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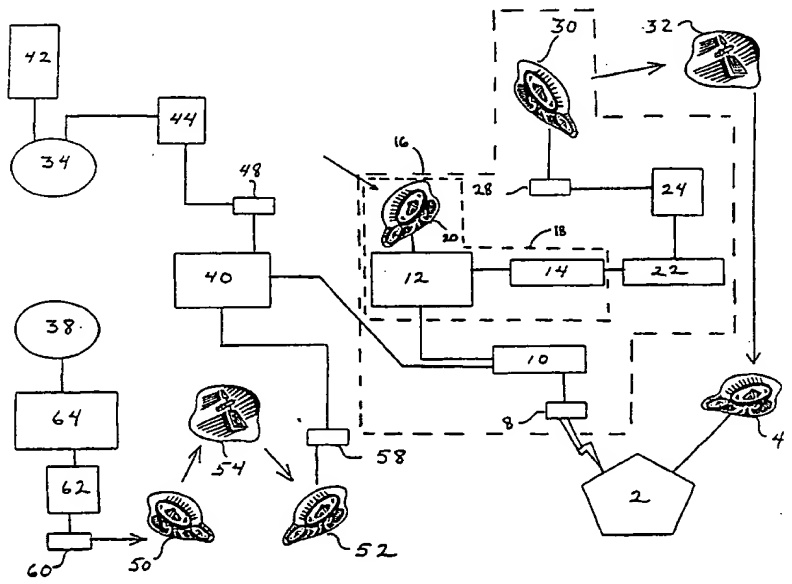

(57) Abstract

Systems and methods of the invention can deliver a plurality of types of data content to data users via a satellite telecommunication network by managing the allocation of the system's available bandwidth resources needed to transmit the plurality of types of data content to data uses. In some embodiments of the inventions, queuing methodologies can be adopted to queue digital data content that is to be transmitted to data users so as to more efficiently utilize the available bandwidth resources found within a satellite telecommunications network.

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INTEGRATED HIGH SPEED TERRESTRIAL & SATELLITE COMMUNICATIONS SYSTEMS FOR INTERNET & OTHER USES

INVENTORS: Candace M. Johnson, Angus Lord and Takeshi Stephen Damian Martinez.

Claim of Priority

This case claims priority to USSN 60/128610, entitled Integrated High Speed Terrestrial and Satellite Communications Systems for Internet and Other Uses, and Filed on 8 April 1999, naming Candace M. Johnson, and Angus Lord and Takeshi Stephen Damian Martinez as amended, as inventors, the contents of which are herein incorporated by reference.

Background of the Invention

1. Field of the Invention

The present application relates to systems and methods for managing the delivery of a plurality of types of data content to data users, and more particularly, to systems and methods for managing the allocation of bandwidth resources for the transmission and delivery of a plurality of types of data content to data users via a satellite telecommunications network.

2. Description of the Related Art

The growth of reasonably priced satellite communications services has led to the availability of a variety of wide band and narrow band communications services for millions of customers. Additionally, there has been an expansion in the number and variety of Internet services accessible by diverse users. To relate the satellite based communications services and the terrestrial Internet facilities, there is a need for an integrated high speed communications systems manager that can coordinate factors pertaining to connectivity, system structure, bandwidth and media format of requested data content comprised of differing data protocols.

A network communications system's ability to deliver data content to its data users is often constrained by the available bandwidth resources found within the system. The

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amount of bandwidth resources that can be made available to any individual data user within a network communications system is dependent upon such factors as the total bandwidth resources available within the system, the number of data users connected to the system, and the size of the data content being demanded by such data users at any given moment. The first factor, the amount of bandwidth resources found within a given network communication system, however, tends to be the single most important factor influencing the quality of service (in terms of the systems' ability to deliver data content in a timely fashion) experienced by the system's data users; other factors tend to only address how the system's available resources are to be allocated to meet the needs of its data users. The amount of bandwidth resources found within a given network can be constrained by both the physical properties of the medium over which the system's data content is delivered to its data users, and in the way in which the system transmits data content to its data users (note, however, that these factors are not generally wholly independent of each other).

These constraints on bandwidth resources can easily be seen in typical non-wireless terrestrial Internet communication networks. Data users can access data content found on the Internet through an Internet service provider. Commonly, the data user communicates with the Internet service provider and the holders of desired data content through normal telephone lines; a request for data content travels from the data user to the holder of the desired data content and then the holder transmits the data content to the requesting data user. This typical terrestrial Internet network system, however, suffers two drawbacks that constrain the amount of available bandwidth resources that the data user may utilize in obtaining the desired data content. First, the amount of bandwidth resources available to deliver data content in existing telephone lines is quite limited. Due to the physical properties of existing telephone lines, the ability to deliver data content to data users in a timely fashion - the amount of bandwidth resources available for a particular data user - particularly when a large number of data users are connected to the network system, may be quite constrained. Secondly, this typical non-wireless Internet network system is constrained in its ability to simultaneously deliver different data content to separate data users since these systems only deliver data content to any specific data user in response to that data user's request for data content. Non-wireless Internet communication networks are constrained in their ability to deliver data content, in other words, because they are unicast systems. With each data user's request for data content,

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the non-wireless Internet communication network system must allocate bandwidth resources to transmit the data content to the requesting data user.

Summary of the Invention

One objective of the present invention is to provide systems and methods that take advantage of the broadband resources available in satellite telecommunication network systems to deliver Internet Protocol (IP) data content to data users at rates of speed that may not be available in traditional terrestrially-based Internet communication networks. It is understood that satellite networks presently exist in the United States, Asia and Europe that were originally installed for television distribution broadcasting. As an example, the ASTRA satellite system in Europe currently provides television broadcast service to approximately twenty-five million homes. It is desirable to expand the use of satellite telecommunication networks by integrating them with the terrestrially-based Internet, thereby adding a new dimension of service for customers of satellite-delivered data content. It is an object of the present invention to provide a system that interrelates terrestrial Internet facilities having wide band distribution capabilities with a select number of satellite terminals linked to telecommunications satellites. It is understood that the term "Internet facility" includes both Internet service providers and Internet content providers.

An additional objective of the present invention is to provide systems and methods that are able to deliver non-Internet Protocol data content to data users by utilizing the broadband resources available in satellite telecommunication network systems. By utilizing the broadband resources available in satellite telecommunication network systems, the delivery of continuous streams of digital data content to data users, at rates of speed not achievable in traditional non-wireless communication networks, may be possible. For example, a MPEG4 stream of audio or video digital data content, such as MPEG4-formatted data, may be delivered to data users in this way. Similarly, non-IP, non-streaming digital data content can also be delivered to data users by utilizing the broadband resources available in satellite telecommunication network systems. Thus, the delivery of digital data content (i.e., file transfers) to data users can be conducted via satellite telecommunication networks at rates of speed which may not be achievable in a traditional non-wireless communication network.

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Another objective of the present invention is to provide systems and methods that take advantage of the multicasting capabilities of satellite telecommunication network systems so as to be able to simultaneously deliver data content to a multitude of data users with a single transmission of the data content. Additionally, to take further advantage of the multicasting capabilities of satellite telecommunication networks, methods for queuing the delivery of digital data content to data users are disclosed in the present invention.

A further object of the present invention is to provide systems and methods for delivering a plurality of types of data content to data users via a satellite telecommunication network. To facilitate this, an integrated communications system manager may provide bi-directional control and signaling capability interconnecting a plurality of diverse bandwidth-originating communications networks, an integrated high speed data content manager and a distribution network. It is understood that a distribution network may comprise a plurality of distribution networks, some of which are dynamically established and disestablished in accordance with the requirements of customers and/or the dictates of an operating protocol. An advantageous aspect of a communications system would be a system manager that can direct the constitution of the aforesaid dynamic networks and that can coordinate their interrelation with other components of the communications system. A plurality of types of data content such as IP data packets, streaming digital data content and file transfers of stored digital data content, for example, could be delivered to and received by data users simultaneously in this way.

The systems and methods described herein allocate bandwidth resources for the delivery of a plurality of types of data content to data users via a satellite telecommunications network. In one embodiment of the invention, the system includes a telecommunications facility, a plurality of communications networks, a satellite, a ground-based satellite receiving antenna and a data user terminal. The telecommunications facility may be capable of receiving differing types of data content delivered from a plurality of communications networks, wherein the plurality of communications networks may be comprised of an Internet service provider which is capable of transmitting Internet Protocol data packets to the telecommunications facility in response to requests from data users, a second communications network which is capable of transmitting streams of digital data content to the telecommunications facility, and a third communications network which is capable of transmitting digital data content to the telecommunications facility which may be in response

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to requests from data users. In a preferred embodiment, the second communications network would be capable of transmitting streams of digital data content formatted in the MPEG4 protocol. Additionally, the telecommunications facility may be capable of allocating the system's bandwidth resources for the delivery of the received types of data content, and transmitting the received types of data content to at least one satellite. The satellite, which may be capable of receiving the different types of data content, receives the plurality of types of data content transmitted from the telecommunications facility and transmits the types of data content to at least one ground-based receiving antenna. The ground-based satellite receiving antenna then receives the transmitted types of data content and directs the data content to at least one data user terminal which is capable of processing and displaying the plurality of types of data content received by the at least one ground-based satellite receiving antenna. In such an embodiment, delivering a plurality of types of data content to data users via a satellite telecommunication network according to the invention can be accomplished.

In one embodiment of the invention, a telecommunications facility may consist of a communications systems manager, a dial-up modem, a dial-up router, a satellite gateway, a satellite modem and at least one satellite antenna. The dial-up modem may serve to provide an interface with the at least one data user terminal. The dial-up router of the telecommunication facility and the dial-up router may serve to route a data user's request for data content to the communications systems manager. The communications system manager of the telecommunications facility may serve to manage the plurality of types of data content received, allocate the available bandwidth resources for the transmission of the plurality of types of data content, and direct the data content to the satellite gateway. Additionally, the satellite gateway may serve to convert the data content directed from the communications system manager to a desired satellite protocol with the satellite modem serving to provide an interface with the satellite gateway of the telecommunications facility and the satellite communication network. Furthermore, the at least one satellite antenna may transmit the plurality of types of data content to the at least one satellite of the satellite communication network. In a preferred embodiment of the invention, a radio frequency (rf) multiplexer may be utilized to further control the plurality of types of data content transmitted by the telecommunications facility.

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Additionally, to manage and direct the plurality of types of data content received, and to allocate the available bandwidth resources for the transmission of the plurality of types of data content, the communications systems manager may comprise of a data content manager and an intermediate router/traffic shaper. In such an embodiment, the data content manager would be responsible for managing the data users' requests for differing types of data content and managing the reception of received plurality of types of data content. In some embodiments of the invention, the data content manager may be comprised of a memory device which is capable of storing a plurality of types of data content, a processor for identifying digital data content to be placed in a queue for transmission, a queuing engine for queuing one or more digital data content identified by the processor and releasing the queued digital data content at predetermined times to the intermediate router/traffic shaper, and a generator for generating messages to be broadcast to data users informing the data users that the queued digital data content will be available for transmission at a predetermined time and inviting the data users to request the queued digital data content prior to the predetermined time for releasing the queued digital data content. In some embodiments, furthermore, the communications system manager may be further comprised of a satellite antenna and a satellite modem so as to be able to receive streams of digital data content delivered from the second communications network and to direct these received digital data content to the data content manager.

In accordance with the invention, the intermediate router/traffic shaper would be responsible for allocating the system's available bandwidth resources for the transmission of the plurality of types of data content received. In one embodiment, the intermediate router/traffic shaper could allocate the available bandwidth resources for the transmission of the plurality of types of data content according to a predetermined schedule based upon historical data user traffic patterns. In another embodiment, the intermediate router/traffic shaper could allocate the available bandwidth resources based on utilization feedback input measurements of said types of data content being transmitted by said communications facility. In yet another embodiment, the intermediate router/traffic shaper could allocate the available bandwidth resources so as to substantially equalize the effective bandwidth experienced by each data user.

In some embodiments of the invention, the method for allocating the system's available bandwidth resources for the transmission of the plurality of types of data content received

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from a plurality of communications networks may comprise monitoring the receipt of data user requests for the transmission of digital data content and placing the data user's request for transmission of digital data content in a queue for transmitting the requested digital data content. The system may then broadcast to other data users to inform them that the queued digital data content will be available for transmission at a predetermined time, and invite these other data users to request the queued digital data content prior to the predetermined time. At the predetermined time, the system then transmits the queued digital data content to the original data user requestor and all other later data user requestors. These methods for allocating the system's available bandwidth resources can be accomplished by utilizing a data content manager including a memory device which is capable of storing a plurality of types of data content, a processor for identifying digital data content to be placed in a queue for later transmission, a queuing engine for queuing one or more digital data content identified by the processor and releasing queued digital data content at predetermined times to the intermediate router/traffic shaper, and a generator for generating messages to be broadcast to data users informing the data users that the queued digital data content will be available for transmission at a predetermined time and inviting the data users to request the queued digital data content prior to the predetermined time for releasing the queued data content.

By allocating the system's available bandwidth resources in this way, one can take advantage of a satellite telecommunication network's ability to multicast digital data content to a multitude of data users in a single data content transmission. In these embodiments, the system may intentionally delay the transmission of the requested digital data content to the original data user/requestor so that additional data users desiring the requested digital data content can be identified. By identifying many data users who wish to receive the requested digital data content, the system may more efficiently utilize its existing bandwidth resources by taking advantage of a satellite telecommunication network's ability to multicast data content to data users.

In some embodiments of the invention, the length of the queue may be a fixed length of time measured from the time at which the initial data user request is received. In others, the length of the queue, as measured from the time at which the initial data user request is received, may be dependent upon the bandwidth resources available within the system. In yet others, the length of the queue, as measured from the time at which the initial data user

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request is received, may be dependent upon the size of the requested digital data content. In alternate embodiments, the predetermined time for the transmission of the requested digital data may be based upon historical data user traffic patterns.

In some other embodiments of the invention, the method for allocating the system's available bandwidth resources for the transmission of the plurality of types of data content received from a plurality of communications networks may comprise placing digital data content in a queue for later transmission and then broadcasting to data users that the queued digital data content will be available for transmission at a predetermined time so as to invite the data users to request the queued digital data content prior to the predetermined transmission time. At the predetermined time, the system then transmits the queued digital data content to those data users who have requested it. These methods for allocating the system's available bandwidth resources can be accomplished by utilizing a data content manager comprising of a memory device, a processor, a queuing engine, and a generator, as discussed above. Unlike the method discussed above, however, this method makes digital data content available to data users without first requiring a data user to request such digital data content. However, like the method discussed above, by identifying many data users who wish to receive the requested digital data content, this method also allows the system to more efficiently utilize its existing bandwidth resources by taking advantage of a satellite telecommunication network's ability to multicast data content to data users.

In one embodiment of this method, the predetermined time for the transmission of the queued digital data content may be based upon historical data user traffic patterns. In another embodiment, the predetermined time for the transmission of the queued digital data content may be dependent upon the bandwidth resources available within the system. In yet another embodiment of this method, the predetermined time for the transmission of the queued digital data content may be dependent upon the size of said queued digital data content.

Brief Description of the Drawings

The foregoing and other objects and advantages of the invention will be appreciated more fully from the following further description thereof, with reference to the accompanying drawings wherein;

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Figure 1 depicts one embodiment of the invention to deliver a plurality of data content to data users via a satellite telecommunication network.

Figure 2 depicts a system for queuing and releasing digital data content in accordance with the invention.

Figure 3 depicts a typical allocation of a satellite telecommunication network's available bandwidth resources to differing types of data content.

Figure 4 depicts a functional block diagram of an embodiment of a system according to the present invention that interrelates terrestrial and satellite communications to deliver a plurality of types of data content.

Figure 5 depicts a block diagram of one embodiment of a data user terminal in accordance with the present invention.

Detailed Description of the Illustrated Embodiments

To provide an overall understanding of the invention, certain illustrative embodiments will now be described. However, it will be understood by one of ordinary skill in the art that the systems and methods herein described can be adapted and modified without departing from the scope of the invention.

The systems and methods of the present invention create a new Internet capability that permits the worldwide distribution of media content at megabit bandwidth. Such an architecture can involve the integration and combination of current terrestrial Internet facilities with the wide spread availability of high speed information channels that is associated with the complex of satellite television distribution networks located throughout the world.

Figure 1 provides a block diagram of an illustrative embodiment of an integrated terrestrial/satellite architecture. According to one embodiment of the present invention,

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the interrelationships comprising the architecture are controlled and managed by a telecommunications facility 16, as shown in Figure 1. According to the depicted system, a plurality of types of data content may be delivered to at least one data user terminal 2. The plurality of types of data content deliverable to the at least one data user terminal may include, but is not limited to, Internet Protocol data content, streaming audio and video digital data content, and non-streaming digital data content. The data user terminal 2 may include, for example, a PC assembly, a standard television set equipped with a set top box mechanism, a laptop computer, or any other device capable of processing and displaying a plurality of types of data content. An arrangement of the data user terminal 2 is shown in more detail in Figure 5. The data user terminal 2 is adapted so as to be able to process and display the plurality of types of data content received by a ground-based satellite receiving antenna 4. The data user terminal 2 is interconnected via a communication device such as a modem (not shown) to a dial-up modem 8 providing an interface with the data user terminal 2 and the telecommunications facility 16. In one embodiment of the invention, the data user terminal 2 (and its modem) may interface directly with the dial-up modem 8 via a direct line dial-up connection. Alternatively, the data user terminal 2 (and its modem) may interface with modem 8 through the Internet via an Internet service provider. The telecommunications facility 16 can include a dial-up router 10 for routing data users' requests for data content to a communications systems manager 18. The communications systems manager 18 as shown comprises of a data content manager 12 , an intermediate router/traffic shaper 14, a satellite antenna 20 and a satellite modem (not shown). The data content manager 12 is responsible for managing the data users' requests for differing types of data content and managing the reception of the received plurality of types of data content. The intermediate router/traffic shaper 14 is responsible for allocating the system's available bandwidth resources for the transmission of the plurality of types of data content received and directing the plurality of types of data content to a satellite gateway 22. In the illustrated embodiment, the data content manager 18 also includes a satellite antenna 20 and a satellite modem (not shown) so that the telecommunications facility 16 will be capable of receiving streams of digital data content delivered from a communications network and to direct the received digital data content to the data content manager 12. Optionally, this communications network may transmit streams of digital data content formatted in the MPEG4 protocol to the telecommunications facility 16.

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Figure 2 illustrates one embodiment of a data content manager 12 in accordance with the invention. The data content manager 12 shown comprises of a processor 70, a queuing engine 72, a generator 74, and a memory device 76. The processor 70 is responsible for controlling the received plurality of types of data content and for identifying digital data content to be placed in a queue for transmission. The processor 70 is capable of communicating with, and controlling, the queuing engine 70, the generator 74 and the memory device 76. The queuing engine 72 queues digital data content identified by the processor 70 to be queued, and releases the queued digital data content at predetermined times to the intermediate router/traffic shaper 14. The generator 74 generates messages to be broadcasted to data users informing them that a queued digital data content will be available for transmission at a predetermined time and inviting these data users to request the queued digital data content prior to the predetermined time for releasing the queued digital data content.

Although Figure 2 graphically depicts the processor 70, the queuing engine 72, a generator 74, and the memory device 79 of the data content manager 12 as functional block elements, it will be apparent to one of ordinary skill in the art that these elements can be realized as computer programs or portions of computer programs according to the invention. The data content manager 12 can be realized as a software component operating on a conventional data processing system such as a Unix workstation. In that embodiment, the data content manager 12 can be implemented as a C language computer program, or a computer program written in any high level language including C++, Fortran, Java or basic. Additionally, in an embodiment where microcontrollers or DSPs are employed, the data content manager 12 can be realized as a computer program written in microcode or written in a high level language and compiled down to microcode that can be executed on the platform employed.

Data content can be introduced into the processor 70 via three separate communications networks. While the illustrated embodiment depicts a preferred embodiment of the invention, it will be readily apparent to one skilled in the art, however, that the depicted embodiment may be modified or adapted without departing from the scope of the invention. The first communications network represents data content available on the Internet, which may be delivered to the processor 70 via the backbone router 40 and dial-

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up router 10 as discussed below. The second communications network comprises a network which generates streams of digital data content deliverable to the processor 70. This communications network may consist of streams of digital data content broadcasted via satellite communications as shown by the satellite antenna 20 in both Figures 1 and 2. The streams of digital data content, however, in accordance with the invention, need not be delivered to the processor 70 of the data content manager 12 via a satellite network. Streams of digital data content, for example, may be delivered to the processor 70 via a television cable broadcasting system. The third communications network comprises a network where digital data content is delivered to the processor 70. The digital data content of this network may be deliverable to the processor 70 of the data content manager 12 via a LAN (or equivalent) system connection 78, or the digital data content may be directly downloaded into a memory device 76 via a driver interface (not shown). The memory device 76 additionally may be utilized to store any data content delivered to the processor 70 from the first and second communications networks.

By controlling the queuing engine 70, the generator 74 and the memory device 76 via the processor 70, the data content manager 12 can control the delivery of the plurality of types of data content to the intermediate router/traffic shaper 14 for transmission to data users. A key feature of the data content manager 12 is its ability to queue digital data content for transmission to data users. For example, if data users wanted to download the latest version of an Internet browser engine, a data content which may be quite large, the data content manager 12 might queue the desired data content for a later transmission to data users. In this way, the system can better utilize its available bandwidth resources by taking advantage of a satellite telecommunication network's ability to multicast data content to data users. By identifying a multitude of data users who desire particular data content and being able to transmit the data content to them in a single transmission, the use of the system's available bandwidth resources can be better utilized. There are many ways in which this can be accomplished. In some embodiments, the identification of the digital data content to be queued will be determined by evaluating the likelihood that other data users might desire the digital data content requested by single data user. In other embodiments the identification of the digital data content to be queued is made independent of a whether a data user has requested a particular digital data content. In both of these approaches, the queuing engine 72's predetermined time for releasing a

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queued digital data content may be based upon historical data user traffic patterns. For example, queued digital data content may be released for transmission to data users in the early morning hours when data user demand upon the system is traditionally at its lowest. Furthermore, in other embodiments of the invention, the queuing engine 72's predetermined time for releasing a queued digital data content may be dependent upon either the bandwidth resources available within the system or upon the size of the queued digital data content.

When the identification of digital data content to be queued is predicated upon a data user requesting such digital data content, the queuing engine 72 of the data content manager 12 may queue the identified digital data content for a fixed length of time measured from the time at which a data user's request for that digital data content is received. Alternatively, the queuing engine 72 may queue the digital data content until a predetermined time wherein the predetermined time, as measured from the time at which the initial data user request is received, is dependent upon the bandwidth resources available within the system or upon the size of said requested digital data content. Or the queuing engine 72 may queue the digital data content until a predetermined time wherein the predetermined time for the transmission of the requested digital data, as discussed above, is based upon historical data user traffic patterns.

Referring to the illustrated embodiment of Figure 1 again, the figure further shows the interface of the systems of the present invention with established terrestrial backbone networks. Data content can enter the dial-up router 10 of the telecommunications facility 16 by way of a backbone router 40. In the embodiment shown in Figure 1, the backbone router 40 is a hub (i.e., node) within the World Wide Web (or the Internet) where signals (i.e., data content) from either a European backbone network 34 or a U.S. backbone network 38 pass through. It is understood that linkages with other geographically established backbone systems can be established without departing from the scope of this invention. The embodiment depicted in Figure 1 shows the European backbone network 34 supported by a terabit caching server 42. Signals from the European backbone network 34 are conveyed to the backbone router 40 via a G703 modem 48 that receives E1 clear channel signals from a facility such as the Luxembourg PTT 44. The embodiment in Figure 1 further shows the U.S. backbone network 38 connected to the

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telecommunications facility 16 of the present invention via a satellite linkage, shown here with two representative satellite antennas 50 and 52 and a representative satellite 54. It is understood, however, that the systems and methods of the present invention can interface with a plurality of satellites, antennas or networks of the same, including non-wireless systems. In the illustrated embodiment, one satellite antenna 52 interfaces with a satellite modem 58 interconnected to the backbone router 40. A second satellite antenna 50 interfaces with a satellite modem 60 that provides a gateway to the U.S. backbone network 38. In the illustrated embodiment, the satellite modem 60 transmits bidirectional signals that pass through a frame relay switch 62 en route to a router 64 that is connected to the U.S. backbone network 38. Signals passing from the router 64 to the satellite modem 60 can be transmitted at a rate differing from the rate at which signals pass in the opposite direction. It is to be understood that these data rates are illustrative only, to be selected according to the particular application, and that modifications thereof will be readily apparent to those of ordinary skill in the relevant arts.

The operating protocol standard that is employed widely throughout the World Wide Web (Internet Protocol or "IP") may be extended to satellite communication networks, distributed to individual data user terminals 2. Through the address and control fields generated by the telecommunications facility 16, a network of terrestrial and satellite communications facilities as shown in Figure 1 can be dynamically configured and reconfigured to provide instantaneous availability of bandwidth on demand, ranging from relatively low speeds in the kilobit range, up to approximately 35 megabits. The delivery points and delivery terminals may also be selected by the customers and users and automatically signaled to participate in a specified "feed". Said bandwidth may be used at customer or user discretion for video streaming, caching, file down loading, multi-casting, and all manner of multi-media distribution.

In accordance with the principles of the invention, a plurality of types of data content may pass from the communications systems manager 18 to a satellite antenna 30 via a satellite gateway 22, that may interface with a radio-frequency (rf) multiplexer 24 where the rf multiplexer 24 can be utilized to further control the plurality of types of data content transmitted by the telecommunications facility, and a satellite modem 28. The radio-frequency multiplexer 24 transmits the plurality of types of data content to the

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satellite antenna 30 by way of the satellite modem 28 which provides an interface between the telecommunications facility and a satellite telecommunications network. The satellite antenna 30 transmits a satellite 32. Figure 1 shows, for purposes of illustration, a single satellite antenna 30 and satellite 32. It is understood, however, that the systems and methods of the present invention can interface with a plurality of satellites, antennas or networks of the same. The satellite 32 is capable of receiving the plurality of types of data content transmitted from the telecommunications facility 16 and transmitting the received types of data content to at least one ground-based satellite receiving antenna 4. The ground-based satellite receiving antenna 4 then receives the plurality of types of data content transmitted by the satellite 32 and directs the plurality of types of data content to a data user terminal 2 which is capable of processing and displaying the plurality of received types of data content.

Figure 3 shows an example of how the instantaneous availability of bandwidth on demand according to an embodiment of the present invention can permit improved planning of a satellite telecommunication network's available bandwidth resources. This improved planning of usage can be advantageous for certain Internet applications, including multimedia distribution and e-commerce, as well as for delivering streaming digital data content and file transfers of digital data content. Figure 3 provides a graph that shows an illustrative deployment of a satellite's available bandwidth resources over a selected twenty-four hour period. The y-axis is calibrated to show a twenty-four hour day. The x-axis legend at the top of the graph is calibrated to show a range of bandwidths from 1 through 38 Mbits/sec. Representative bandwidth utilizations across hours of the day are shown schematically at 200, 202, 204, 208, 210 and 212. The area on the graph of Figure 3 designated 200 can indicate a bandwidth segment that provides streamed digital video data content at a rate of 8 Mbits/sec which is constant throughout the selected 24 hour period. In one embodiment, a MPEG 4 protocol may be used to provide this data content access. The area on the graph of Figure 3 designated 202 can indicate a bandwidth segment that provides streamed digital audio data content at a rate of 12 Mbits/sec which is constant throughout the selected 24 hour period. The area on the graph of Figure 3 designated 204 can represent corporate demands of Internet data content at rates ranging from 3 to 10 Mbits/sec throughout the selected 24 hour period. This area 204 illustrates the variability of bandwidth utilization for this purpose at different times of the day. In an

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exemplary situation, between 15 and 50 data users may be actively downloading at 200 K/bits, consistent with a data user base between 240 and 800 subscribers. The area on the graph of Figure 3 designated 208 can represent corporate demand of Internet data content at rates ranging from 2 to 10 Mbits/sec, which correlates with a set of between 35 and 178 data users actively downloading at 56 Kbits/sec, and which is consistent with a data user base of between 580 and 2850 subscribers. This area 208 illustrates the variability of bandwidth utilization for this purpose at different times of the day. The area on the graph of Figure 3 designated 210 depicts bandwidth availability across time for scheduled downloads from 2 to 10 Mbits/sec. There is also available an area of bandwidth, generally shown at 212, that is allocated to system overhead of 2 Mbits/sec. These deployments of bandwidth utilization across time as depicted in Figure 3 are intended to be illustrative only. It is understood that those of ordinary skill in the relevant arts will be able to envision a plurality of planning strategies that combine the availability of bandwidths at designated time intervals to meet the needs of a particular pool of data users.

Figure 4 shows a functional block diagram of an embodiment of a system according to the present invention that interrelates terrestrial and satellite communications. Figure 4 depicts a communications systems manager 100 that regulates and directs the passage of data content through a gateway router 102 (where the gateway router 102 represents the dial-up modem 8, the dial-up router 10, the satellite gateway 22, and satellite modem 28 from Figure 1). The communications systems manager 100 can include a server (not shown) and proprietary software. Together the systems management controller 100 and the gateway router 102 manage the reception of data content from various inputs (examples shown here at 104, 110, 114 and 118) and manage the transmission of a plurality of data content towards a satellite antenna 132. Through a series of address and control fields generated by the communications systems manager 100, the network structure can be dynamically configured to provide multi-layer addressing and device selectivity, thereby enabling the creation on demand of specifically configured network distribution points and participants. Where necessary, the communications systems manager 100 may arrange the information queues in accordance with the control algorithms that have been specified for the network. This same system of control algorithms can provide the configuration and reconfiguration of the space

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segment, as shown in Figure 3, so as to maintain continuous highly efficient use of space distribution capabilities.

The communications systems manager 100 also can regulate, through software control, the multiplicity of data content inputs as shown in Figure 4. A plurality of types of data content can be received into the communications systems manager 100 from a variety of sources. In the illustrated embodiment, data content can be received from terrestrial data caches 104 which in turn can accept data content from a master cache 108 that cooperates with caches (not shown) of terrestrial partners. Data content can be received from line input sources 110, shown here as connected to remote Internet networks 112. Data content can be received from line connections 114 to third parties. Data content can be received from satellite sources 118 via KU band and future KA band, and can be transmitted thereunto, this bidirectionality being indicated by the double headed arrow at 116. Signals to and from satellite sources 118 can be directed by a separate control system 120 that is in communication with the communications systems manager 100. The communications systems manager 100 can likewise affect the flow of data content from satellite sources 118 into a video server 122, wherefrom data content can be transmitted along an uplink path to a satellite antenna site 132. The satellite antenna site 132 is shown in this figure to be in communication with a satellite 134. It is understood, however, that the systems and methods of the present invention can include a plurality of satellite antenna sites, satellites or networks of the same. The data content transmitted to the video server 122 from satellite sources 118 may take the form of broadcast data content. Data content emerging from the gateway router 102 may be optionally directed into a rf multiplexer 124 to be passed to the satellite antenna site 132. A rf multiplexer 124 can direct data content to a modulator 128 and thence to a transmitter 130 that comprises the satellite antenna site 132. If a multiplexer 124 is not employed, data content can pass directly from the gateway router 102 to the modulator 128.

In one embodiment, the systems according to the present invention can include an apparatus adapted for interface with the consumer's television set or PC to comprise a data user terminal. This apparatus may include both devices and software. As an example, Figure 5 provides a diagram of certain features of such a data user terminal. Figure 5 shows a block diagram of an embodiment of a data user terminal 300 according to the

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systems of the present invention. The data user terminal 300 can be in the form of a PC, a set top box or an Internet box. The data user terminal 300 can comprise a receiver card 308, an ISDN adapter 310 and a software system, depicted diagrammatically generally at 312. The software system 312 can include a stack of interacting layers such as described by the OSI protocol. Figure 5 shows one embodiment of a software system 312, comprising an Internet protocol (IP) layer 314, an UDP/TCP data transfer layer 318 and a data services layer 320, which may include proprietary software for signal processing or for other data processing. In the illustrated embodiment, a monitor 302 and a speaker 304 are shown in communication with the receiver card 308. Figure 5 shows a flow of data from a satellite system 322 into the data user terminal 300 entering the receiver card 308 and passing therefrom into the software system 312. Data content entering the software system 312 pass from the IP layer 314 to the data transfer layer 318 to the data services layer 320. After being processed at the data services layer 320, data content passes through the data transfer layer 318 to the IP layer, to exit the software system 312. Processed data content may then be routed to an ISDN adapter 310 which interfaces with an ISDN 324. Requests for data content transmission can be sent from the consumer data user terminal 300 to the ISDN 324. Responses to such requests can be transmitted from the satellite system 322 into the data user terminal 300. It is understood that the satellite system 322 may comprise satellite receivers, satellites and networks thereof. While the arrangement of components shown in Figure 5 represents an illustrative embodiment according to the systems of the present invention, it is understood that other arrangements can be envisioned by those of ordinary skill in the relevant arts without departing from the scope of the present invention.

The many features and advantages of the present invention can be appreciated from the foregoing description. The specification above provides descriptions of certain embodiments of the present invention to demonstrate its features and advantages more fully. However, since numerous modifications and changes will be apparent to those of ordinary skill in the art, it is not desired to limit the invention to the exact construction and operation as described above. A person skilled in the networking art will readily determine that there are changes and modifications which may extend the usefulness and application of the present invention. Hence, all suitable modifications and equivalents are understood as falling within the scope of the invention.

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Accordingly, it will be understood that the invention is not to be limited to the embodiments disclosed herein, but is to be understood from the following claims, which are to be interpreted as broadly as allowed under the law.

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I claim:

1. A system for delivering a plurality of types of data content to data users via a satellite telecommunication network, comprising:

a telecommunications facility for receiving differing types of data content from a plurality of communications networks, allocating bandwidth resources for the delivery of said plurality of types of data content received from said plurality of communications networks, and transmitting said received types of data content to at least one satellite;

a first communications network comprising an Internet service provider wherein said first communications network transmits Internet Protocol data packets to said telecommunications facility in response to requests from data users;

a second communications network wherein said second communications network transmits streams of digital data content to said telecommunications facility;

a third communications network wherein said third communications network transmits digital data content to said telecommunications facility;

at least one satellite to receive said plurality of types of data content transmitted from said telecommunications facility and to transmit said types of data content to at least one ground-based receiving antenna;

at least one ground-based satellite receiving antenna to receive said transmitted types of data content transmitted from said satellite and direct said plurality of types of data content to a data user terminal; and

at least one data user terminal capable of processing and displaying said plurality of types of data content received by said ground-based satellite receiving antenna.

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2. The system of claim 1 wherein said third communications network transmits said digital data content to said telecommunications facility in response to requests from data users.

3. The system of claim 1 wherein said second communications network transmits streams of digital data content formatted in the MPEG4 protocol.

4. The system of claim 1 wherein said telecommunications facility comprises:

a communications systems manager further comprising:

a data content manager responsible for managing the data users' requests for differing types of data content and managing the reception of received plurality of types of data content; and

an intermediate router/traffic shaper responsible for allocating the system's available bandwidth resources for the transmission of the plurality of types of data content received and directing the plurality of types of data content to a satellite gateway;

a dial-up modem to provide an interface with the data user terminals and said telecommunications facility;

a dial-up router for routing data users' requests for data content to said communications systems manager;

a satellite gateway for converting said plurality of types of digital data content received from said intermediate router/traffic shaper to a desired satellite protocol;

a satellite modem to provide an interface with said telecommunications facility and a satellite telecommunications network; and

at least one satellite antenna for transmitting said plurality of types of data content to at least one satellite within said satellite telecommunications network.

5. The system of claim 4 wherein said telecommunications facility further comprises a radio-frequency multiplexer to further control the plurality of types of data content transmitted by the telecommunications facility

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6. The system of claim 4 wherein said intermediate router/traffic shaper allocates the available bandwidth resources for the transmission of said plurality of received types of data content according to a predetermined schedule based upon historical data user traffic patterns.

7. The system of claim 4 wherein said intermediate router/traffic shaper allocates the available bandwidth resources for the transmission of said plurality of received types of data content based on utilization feedback input measurements of said types of data content being transmitted by said communications facility.

8. The system of claim 4 wherein said intermediate router/traffic shaper allocates the available bandwidth resources for the transmission of said plurality of received types of data content so as to substantially equalize the effective bandwidth experienced by each data user.

9. The system of claim 4 wherein said communications system manager further comprises a satellite antenna and a satellite modem so as to be able to receive streams of digital data content delivered from said second communications network and to direct said received digital data content to said data content manager.

10. The system of claim 4 wherein said data content manager comprises;

a memory device capable of storing a plurality of types of data content;

a processor for identifying digital data content to be placed in a queue for transmission;

a queuing engine for queuing one or more digital data content identified by said processor and releasing said queued digital data content at predetermined times to said intermediate router/traffic shaper; and

a generator for generating messages to be broadcast to data users informing said data users that said queued digital data content will be available for transmission at a predetermined time and inviting said data users to request said queued digital data content prior to said predetermined time for releasing said queued digital data content.

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11. The system of claim 10 wherein said queuing engine's predetermined time for releasing said queued digital data content is based upon historical data user traffic patterns.

12. The system of claim 10 wherein said queuing engine's predetermined time for releasing said queued digital data content is dependent upon the bandwidth resources available within the system.

13. The system of claim 10 wherein said queuing engine's predetermined time for releasing said queued digital data content is dependent upon the size of said queued digital data content.

14. The system of claim 10 wherein the processor identifies digital data content to be placed in a queue for later transmission by monitoring the receipt of data user requests for the transmission of digital data content.

15. The system of claim 14 wherein the queuing engine queues said digital data content identified by said processor for a fixed length of time measured from the time at which a data user request is received.

16. The system of claim 14 wherein the queuing engine queues said digital data content identified by said processor until a predetermined time wherein said predetermined time, as measured from the time at which the initial data user request is received, is dependent upon the bandwidth resources available within the system.

17. The system of claim 14 wherein the queuing engine queues said digital data content identified by said processor until a predetermined time wherein said predetermined time, as measured from the time at which the initial data user request is received, is dependent upon the size of said requested digital data content.

18. The system of claim 14 wherein the queuing engine queues said digital data content identified by said processor until a predetermined time wherein said predetermined time for the transmission of said requested digital data is based upon historical data user traffic patterns.

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19. A method for delivering a plurality of types of data content to data users via a satellite telecommunication network, comprising:

receiving differing types of data content from a plurality of communications networks wherein:

at least one of the communications network is a Internet service provider providing Internet Protocol data packets in response to requests from data users;

at least one of the communications network provides a stream of digital data content; and

at least one of the communications network provides digital data content which may be in response to requests from data users;

allocating bandwidth resources for the transmission of said plurality of types of data content received from said plurality of communications networks; and

transmitting said received types of data content to data users.

20. The method of claim 19 wherein said stream of digital data content is formatted in the MPEG4 protocol.

21. The method of claim 19 wherein the allocation of available bandwidth resources for the transmission of said plurality of received types of data content is established according to historical data user traffic patterns.

22. The method of claim 19 wherein the allocation of available bandwidth resources for the transmission of said plurality of received types of data content is based upon utilization feedback input measurements of said types of data content being transmitted by said communications facility.

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23. The method of claim 19 wherein the allocation of available bandwidth resources for the transmission of said plurality of received types of data content is established so as to substantially equalize the effective bandwidth experienced by each data user.

24. The method of claim 19 wherein the allocation of available bandwidth resources for the transmission of said plurality of received types of data content further comprises:

monitoring the receipt of data user requests for the transmission of digital data content;

placing a data user request for the transmission of digital data content in a queue for transmitting said requested digital data content;

broadcasting to other data users, while said requested digital data content is in said queue, so as to inform said data users that said queued digital data content will be available for transmission at a predetermined time and inviting said data users to request said queued digital data content prior to said predetermined time; and

transmitting said queued digital data content at said predetermined time to said original data user requestor and all other later data user requestors.

25. The method of claim 24 wherein the length of the queue is a fixed length of time measured from the time at which the initial data user request is received.

26. The method of claim 24 wherein the length of the queue, as measured from the time at which the initial data user request is received, is dependent upon the bandwidth resources available within the system.

27. The method of claim 24 wherein the length of the queue, as measured from the time at which the initial data user request is received, is dependent upon the size of said requested digital data content.

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28. The method of claim 24 wherein the predetermined time for the transmission of said requested digital data is based upon historical data user traffic patterns.

29. The method of claim 19 wherein the allocation of available bandwidth resources for the transmission of said plurality of received types of data content further comprises:

placing digital data content in a queue for later transmission of said digital data content;

broadcasting to data users that said queued digital data content will be available for transmission at a predetermined time and inviting said data users to request said queued digital data content prior to said predetermined time; and

transmitting said queued digital data content at said predetermined time to data users who request said queued digital data content.

30. The method of claim 29 wherein the predetermined time for the transmission of said queued digital data content is based upon historical data user traffic patterns.

31. The method of claim 29 wherein the predetermined time for the transmission of said queued digital data content is dependent upon the bandwidth resources available within the system.

32. The method of claim 29 wherein the predetermined time for the transmission of said queued digital data content is dependent upon the size of said queued digital data content.

33. A method for delivering digital data content to data users via a satellite communications network, comprising:

monitoring the receipt of data user requests for the transmission of digital data content;

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placing a data user request for the transmission of digital data content in a queue for transmitting said requested digital data content;

broadcasting to other data users, while said requested digital data content is in said queue, so as to inform said data users that said queued digital data content will be available for transmission at a predetermined time and inviting said data users to request said queued digital data content prior to said predetermined time; and

transmitting said queued digital data content at said predetermined time to said original data user requestor and all other later data user requestors .

34. The method of claim 33 wherein the length of the queue is a fixed length of time measured from the time at which the initial data user request is received.

35. The method of claim 33 wherein the length of the queue, as measured from the time at which the initial data user request is received, is dependent upon the bandwidth resources available within the system.

36. The method of claim 33 wherein the length of the queue, as measured from the time at which the initial data user request is received, is dependent upon the size of said requested digital data content.

37. The method of claim 33 wherein the predetermined time for the transmission of said requested digital data is based upon historical data user traffic patterns.

38. A method for delivering digital data content to data users via a satellite communications network, comprising:

placing digital data content in a queue for later transmission of said digital data content;

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broadcasting to data users that said queued digital data content will be available for transmission at a predetermined time and inviting said data users to request said queued digital data content prior to said predetermined time; and

transmitting said queued digital data content at said predetermined time to data users who request said queued digital data content.

39. The method of claim 38 wherein the predetermined time for the transmission of said queued digital data content is based upon historical data user traffic patterns.

40. The method of claim 38 wherein the predetermined time for the transmission of said queued digital data content is dependent upon the bandwidth resources available within the system.

41. The method of claim 38 wherein the predetermined time for the transmission of said queued digital data content is dependent upon the size of said queued digital data content.

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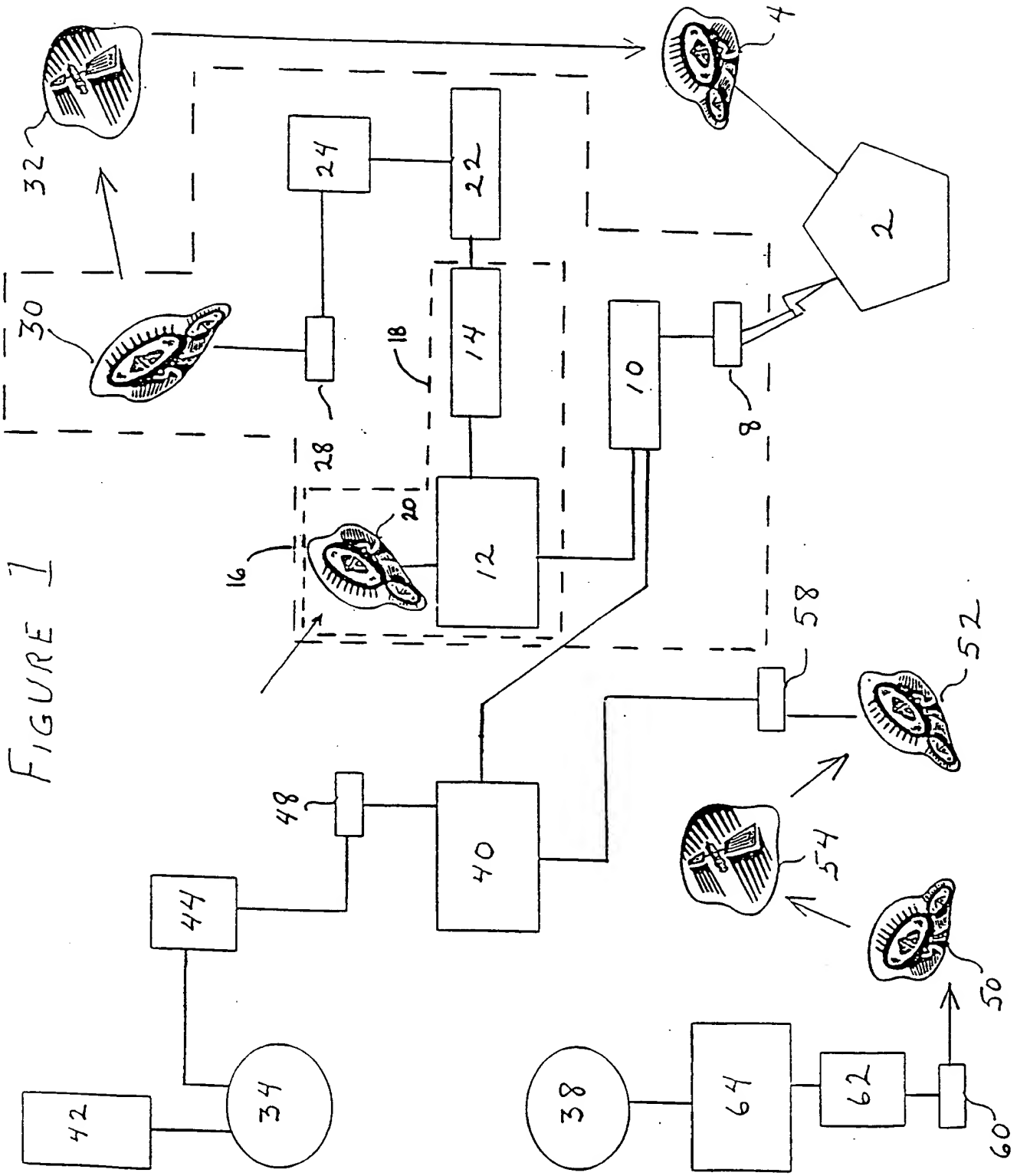
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FIGURE 1

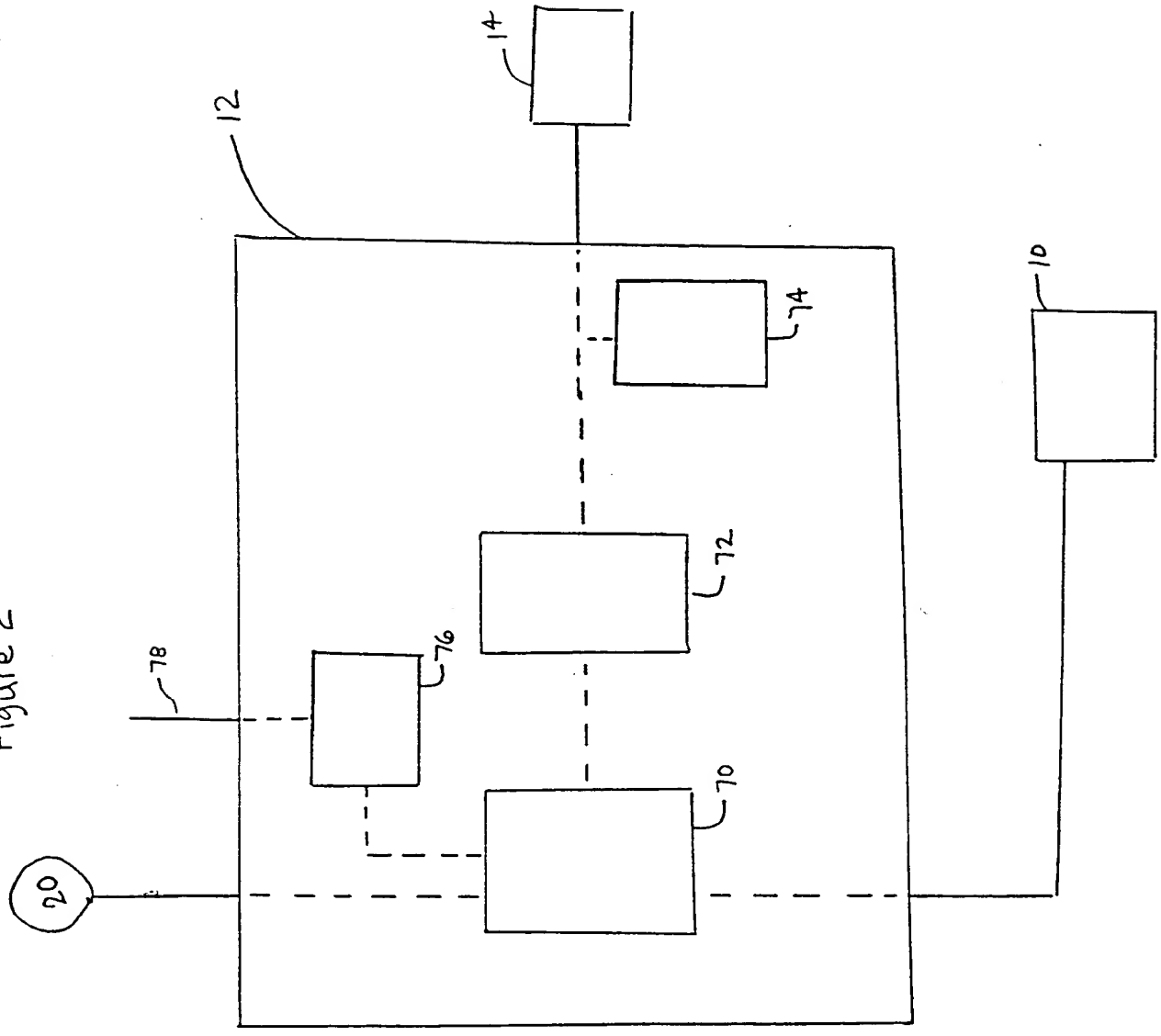

Figure 2

BNSDOCID: <WO___0060770A1_I_>

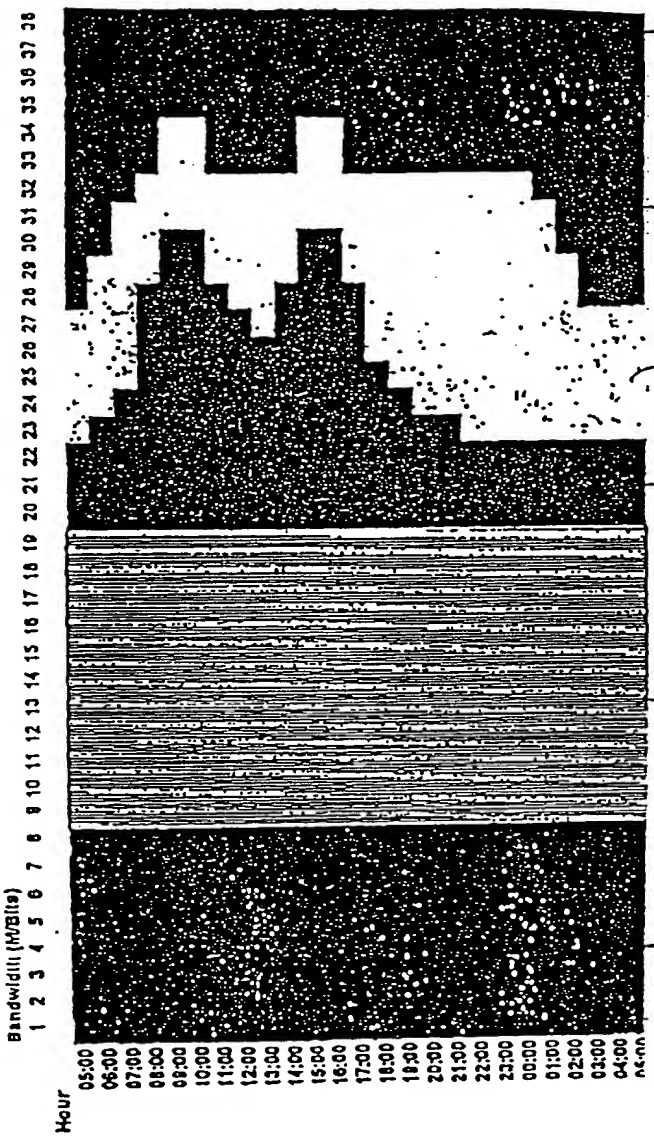
Bandwidth (MBits)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38
Hour
05:00
06:00
07:00
08:00
09:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
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FIGURE 3

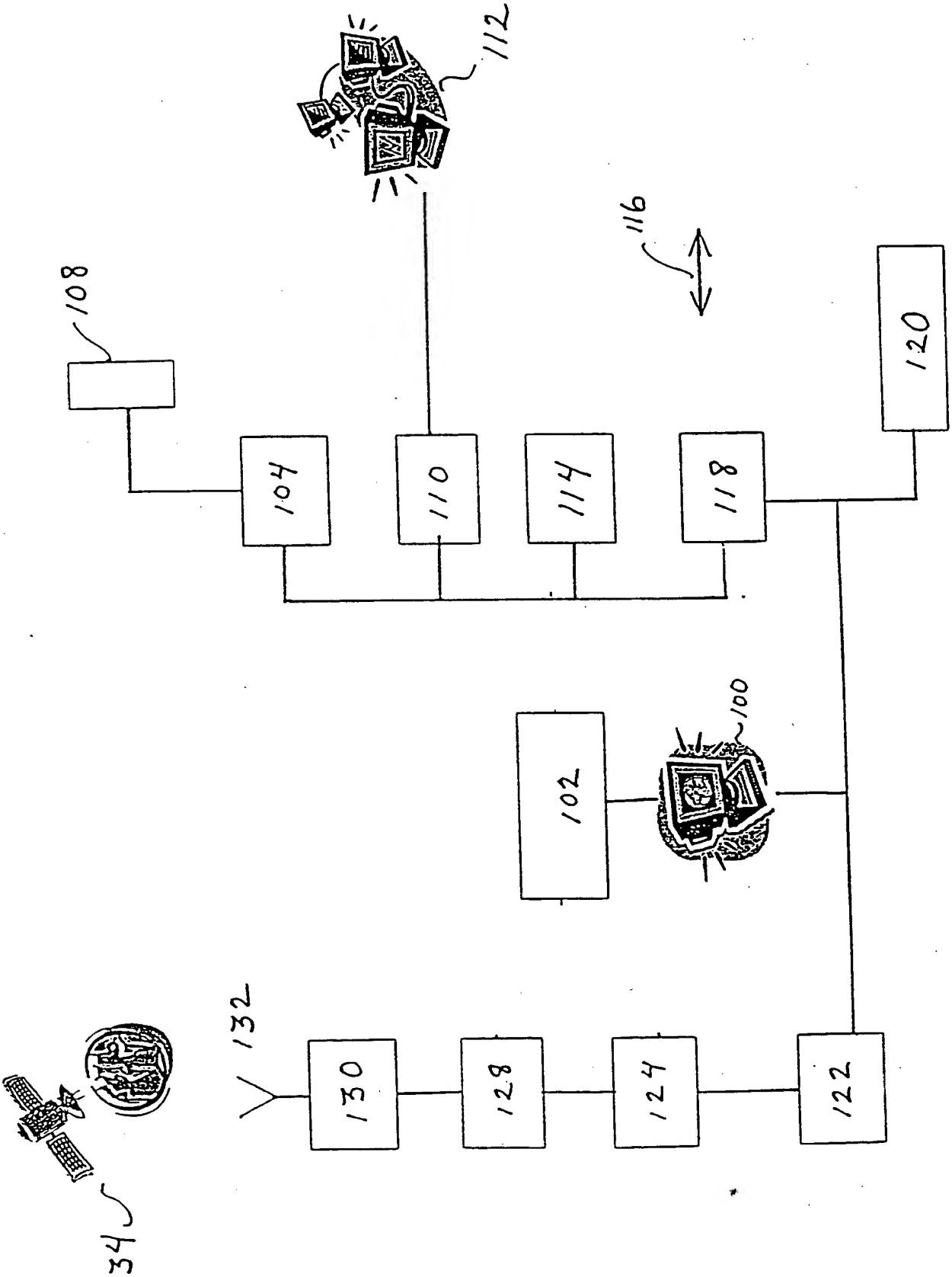

FIGURE 4

BNSDOCID: <WO___0060770A1_1_>

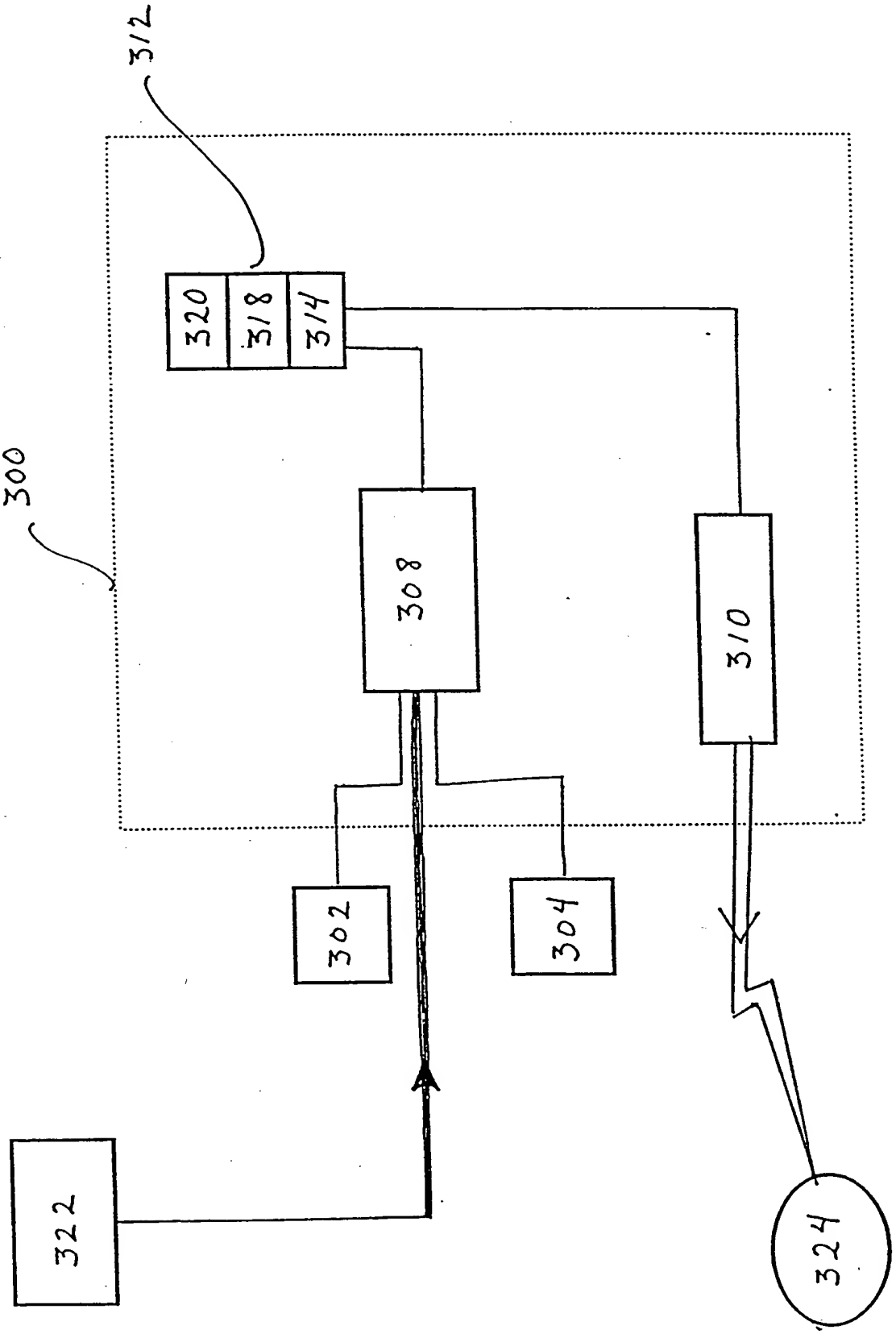

FIGURE 5

INTERNATIONAL SEARCH REPORT

Inte onal Application No
PCT/US 00/09496

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04B7/185

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
WPI Data, PAJ, INSPEC, EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	page 2, line 20 -page 3, line 24 page 5, line 26 -page 12, line 27 figures 1-17	6-8, 11-18, 21-23, 25-28, 30-32, 34-37, 39-41

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
10 August 2000	21/08/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Sorrentino, A

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Form PCT/ISA/210 (second sheet) (July 1992)

BNSDOCID: <WO___0060770A1_I_>

INTERNATIONAL SEARCH REPORT

Inter ›nal Application No
PCT/US 00/09496

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
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A	page 7, line 15 - line 25	6-8, 11-18, 21-23, 25-28, 30-32, 34-37, 39-41
	page 21, line 17 - line 21; figures 1,3	

X	HUNG A ET AL: "ATM VIA SATELLITE: A FRAMEWORK AND IMPLEMENTATION" WIRELESS NETWORKS,US,ACM, vol. 4, no. 2, 1 February 1998 (1998-02-01), pages 141-153, XP000741224 ISSN: 1022-0038	1-5,9, 10,19, 20,24, 29,33,38
A	paragraph '02.1!	6-8, 11-18, 21-23, 25-28, 30-32, 34-37, 39-41
	paragraph '02.2!; figures 2,6	

X	CLAUSEN H D ET AL: "INTERNET SERVIVES VIA DIRECT BROADCAST SATELLITES" IEEE INTERNATIONAL PERFORMANCE, COMPUTING AND COMMUNICATIONS CONFERENCE,US,NEW YORK, IEEE, 5 February 1997 (1997-02-05), pages 468-475, XP000753714 ISBN: 0-7803-3874-X	1,19,33, 38
A	paragraph '0002!; figures 4,5	2-18, 20-32, 34-37, 39-41

X	US 5 852 721 A (GUPTA VIVEK ET AL) 22 December 1998 (1998-12-22) column 2, line 24 - line 48	1,19,33, 38
A	column 3, line 48 -column 4, line 10	2-18, 20-32, 34-37, 39-41

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Form PCT/ISA/210 (continuation of second sheet) (July 1992)

DOCID: <WO___0060770A1_I_>

INTERNATIONAL SEARCH REPORT

Information on patent family members

Inter nal Application No
PCT/US 00/09496

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		US 5995725 A	30-11-1999

BNSDOCID: <WO___0060770A1_I_>

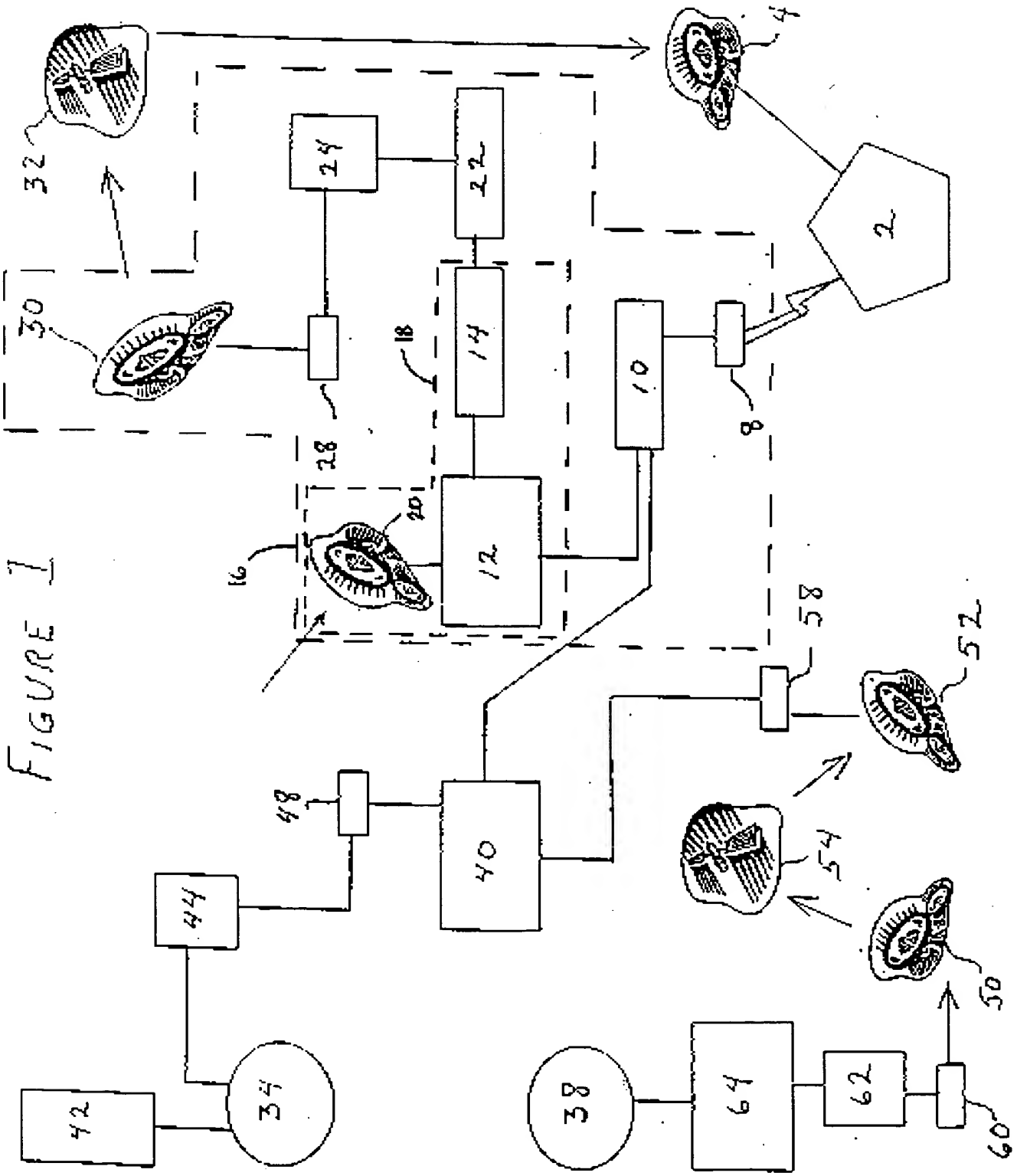
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FIGURE 1

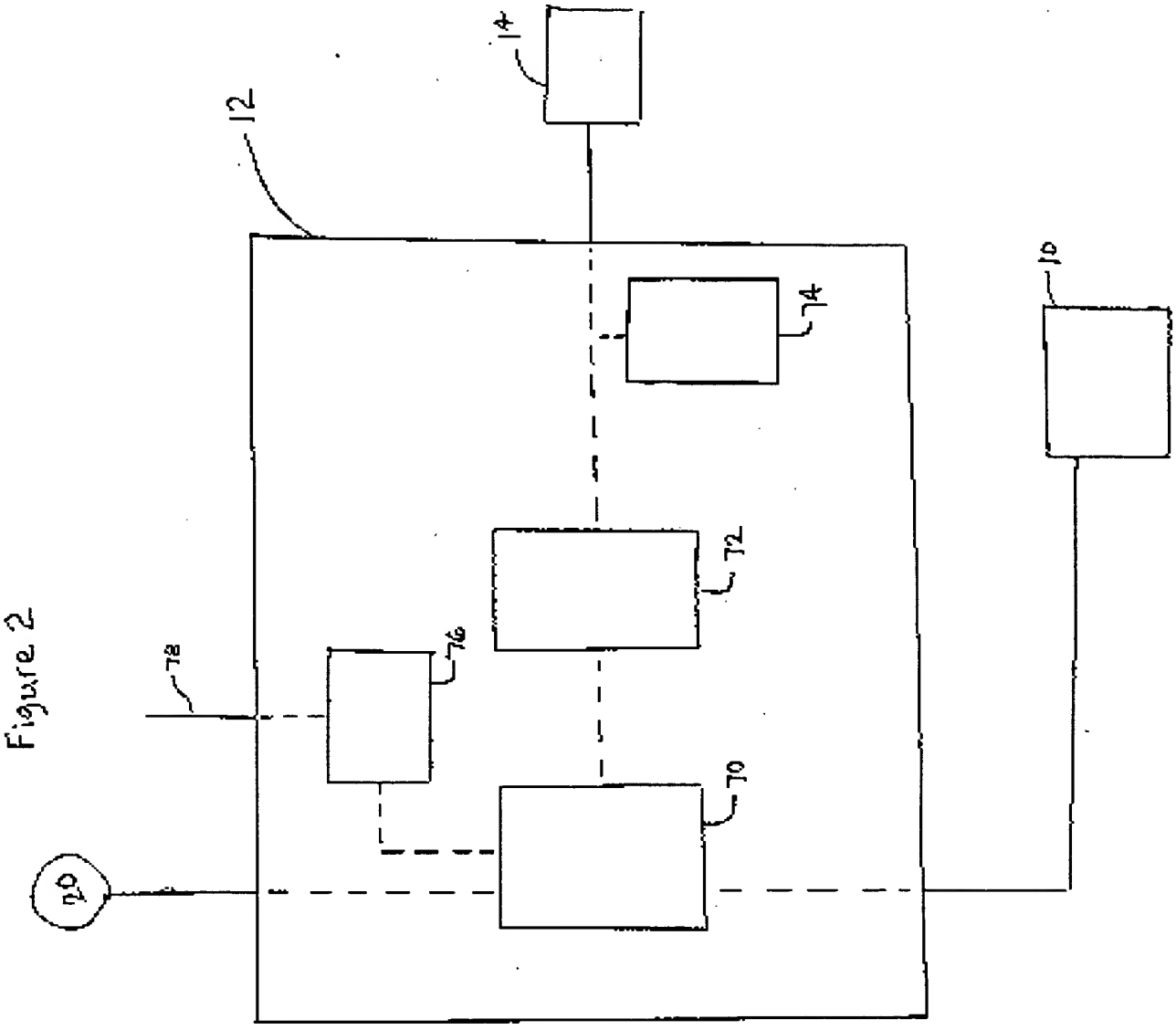

Figure 2

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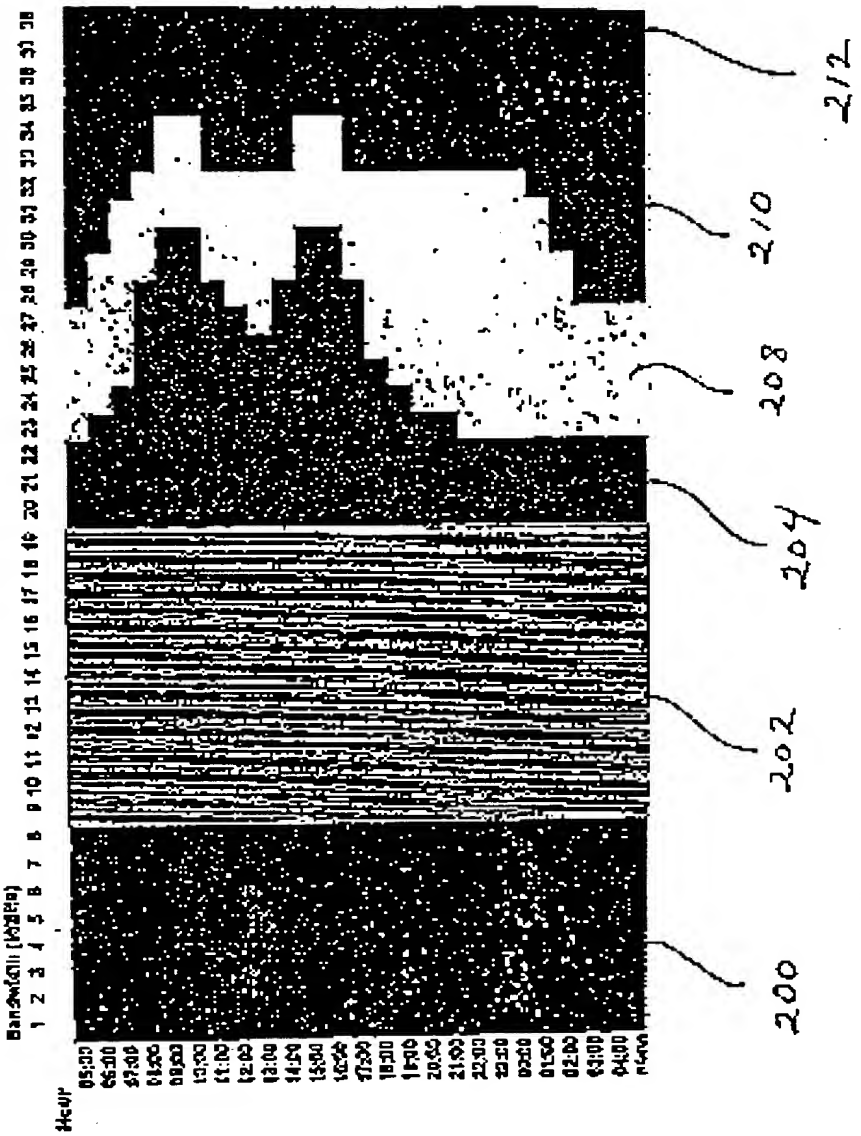

FIGURE 3

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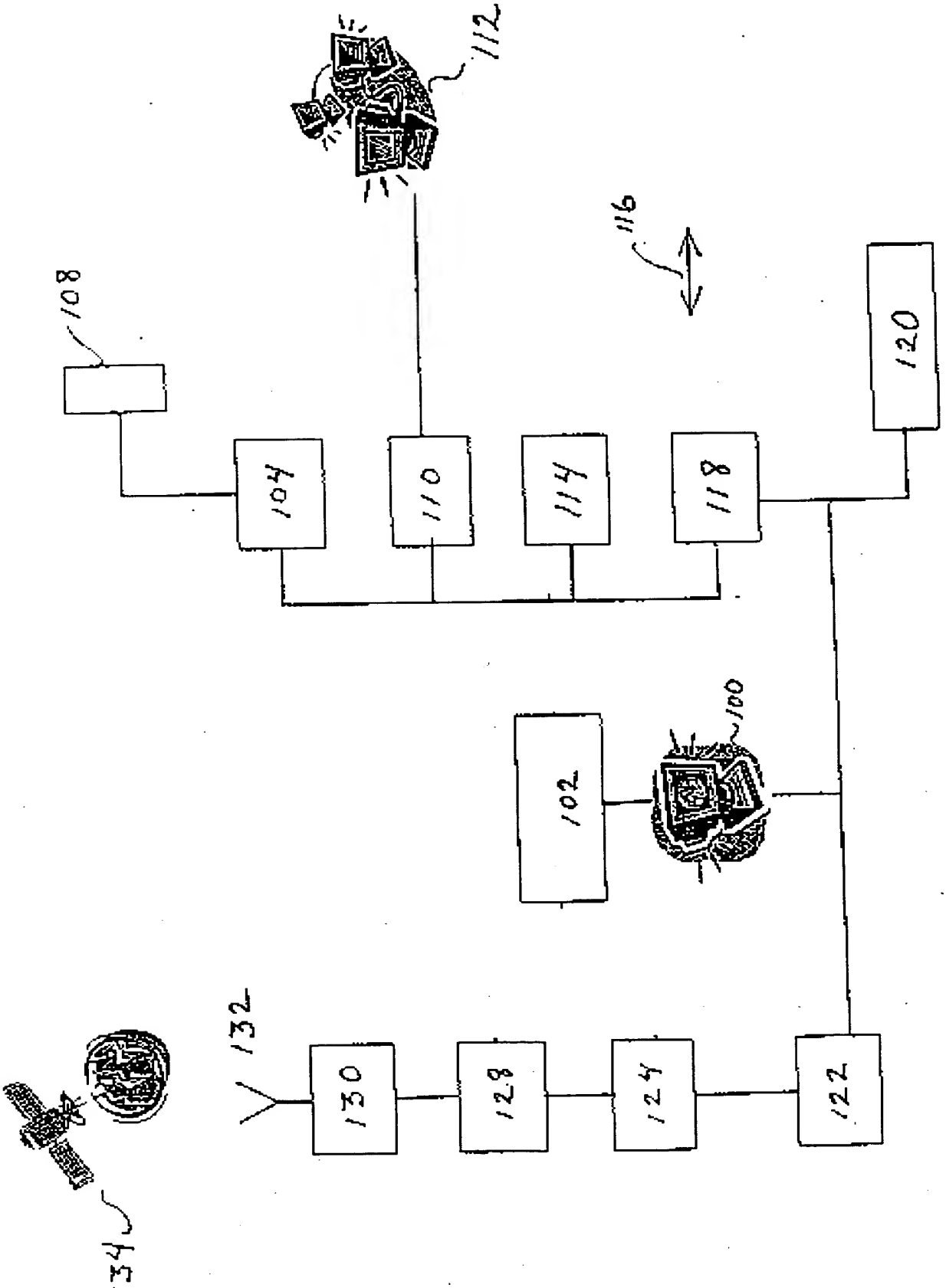

FIGURE 4

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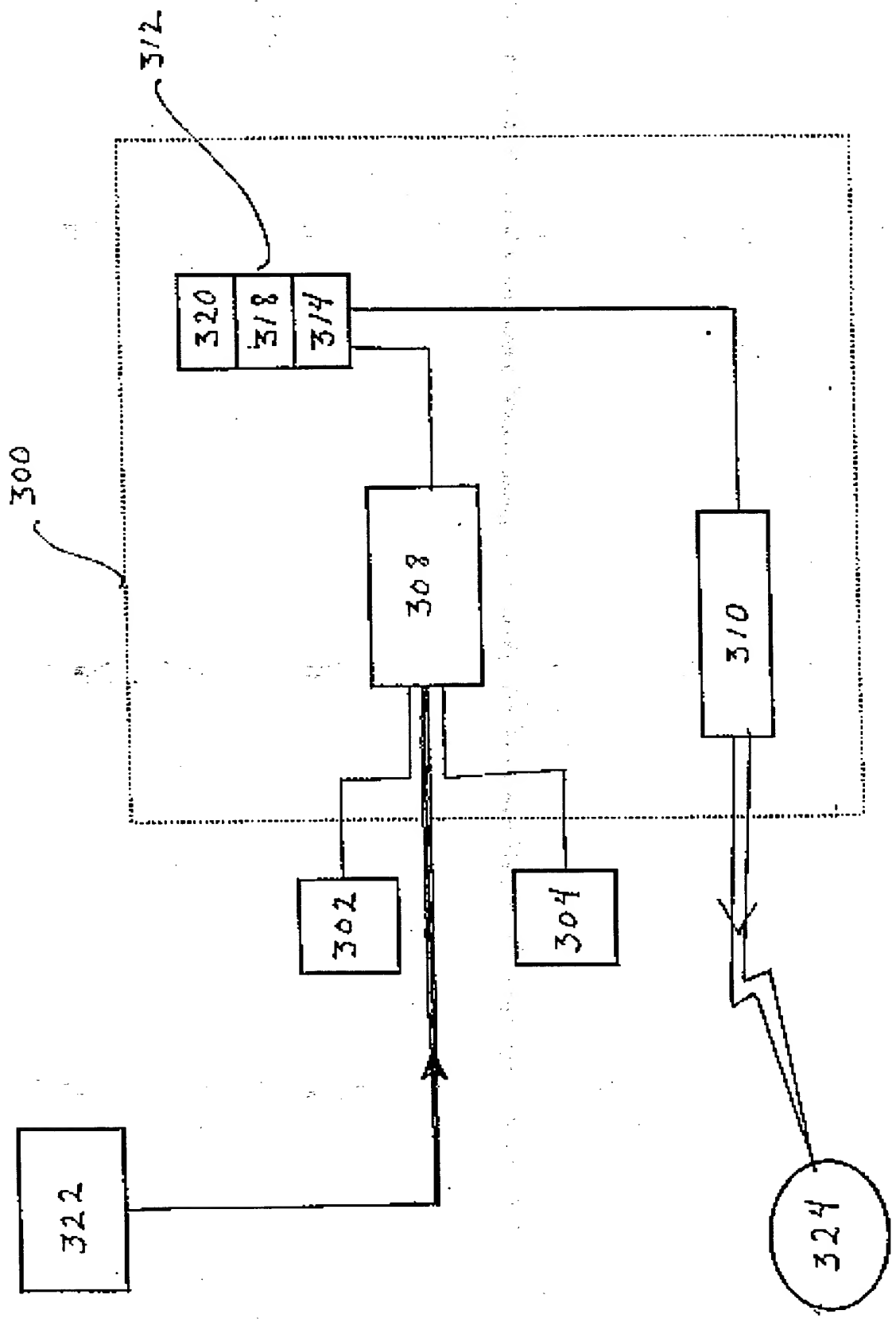

FIGURE 5

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